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| 09/652,991 | 08/31/2000 | Donald L. Yates | MTI-31046 | 4383 |

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| ART UNIT | PAPER NUMBER |
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1765

DATE MAILED: 05/29/2003

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Please find below and/or attached an Office communication concerning this application or proceeding.

| | | | |
|------------------------------|--------------------------------------|---|--|
| Office Action Summary | Application No. 09/652,991 | Applicant(s) YATES, DONALD L. | |
| | Examiner Binh X Tran | Art Unit 1765 | |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 24 February 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☐ Claim(s) 12,13,26,28,79,111-126,131-133,146-148,150-153,155,157 and 158 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 12,13,26,28,79,111-126,131-133,146-148,150-153,155,157 and 158 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s). _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claim 79 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

In claim 79, the examiner cannot find the support for the limitation "the aqueous comprising 2:1 (v/v) ratio of hydrogen fluoride and one or more inorganic acid".

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 12-13, 26, 28, 111-113, 116-119, 123, 125-126, 131-132, 146-148, 150-153, 155, 157-158 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bartlett (US 4,508,591) in view of Yamazaki (US 6,198,133).

Respect to claim 26, Bartlett discloses a method for treating a wafer surface comprising:

providing a wafer surface having a low-k dielectric (silicon dioxide) layer disposed on a portion of the surface(col. 2 lines 23-41);

contacting the surface of the wafer to remove at least a portion of the low-k dielectric layer by applying aqueous solution comprise HF compounds and organic acid such as acetic acid, citric (col. 3).

Bartlett does not explicitly disclose the pH of the aqueous solution. However Bartlett discloses the solution is an acidic buffer solution. Since solution is acidic buffer, the pH of the solution must be less than 7 and greater than 2 (read on pH about 2 to about 6). Bartlett does not disclose the specific removal rate of dielectric layer. However Bartlett teaches that the low-k dielectric is selectively removed. In a semiconductor method, Yamazaki teaches a typical removal rate of silicon oxide (low-k dielectric) at 800-1100 Å using acetic acid and inorganic fluorine-comprising compound.

It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Bartlett in view of Yamazaki by removing the low-k dielectric layer at a rate greater than 1000 angstroms per minute because the high etching rate will reduce the etching time.

Respect to claim 12, Bartlett discloses a photoresist layer (layer 2 and/or 3) overlying the low k dielectric layer (1) (Fig 1-2) as well as remove the low-k dielectric with minimum removal of photoresist layer (Fig 2-3).

Claims 12-13, 111-113, 146-148 differ from Bartlett by the specific ratio of HF to organic acid 2:1 (v/v) and the specific etch rate of the low-k dielectric. However, Bartlett clearly discloses the use of HF and organic acid comprises either acetic acid or citric acid. Bartlett further discloses "the concentration of these chemical primarily affect the etch rate of silicon dioxide" (col. 4 lines 1-5). The examiner interprets that Bartlett clearly teaches that the concentration (i.e. the ratio of HF to organic acid and etch rate is result effective variables). The result effective variables are commonly determined by routine experiment. The process of conducting routine optimization experiments so as to produce an expected result is obvious to one of ordinary skill in the art. Hence, it would have been obvious to one having ordinary skill in the art, at the time of invention, to perform routine experiment to obtain optimal concentration ratio and etch rate as an expect result.

Respect to claim 116, Bartlett disclose the etch composition comprise HF (col. 2) and NH_4F (col. 2 lines 56-57). Respect to claims 117-118 Bartlett teaches the organic acid is selected from the group consisting of acetic, citric, ascorbic (col. 2-3). The limitation of claims 119, 146-148, 150-153, 155, 157-158 has been discussed in previous paragraphs.

Respect to claims 28, 131-132, Bartlett discloses the solution comprise 10-200 grams of citric acid per liter of aqueous solution. Bartlett and Yamazaki differ from these claims by the specific value of volume percentage and etch rate. However, Bartlett discloses "the concentration of these chemical primarily affect the etch rate of silicon dioxide" (col. 4 lines 1-5). The examiner interprets that Bartlett clearly teaches

that the concentration (read on volume percentage) a result effective variable. The result effective variable is commonly determined by routine experiment. The process of conducting routine optimization experiments so as to produce an expected result is obvious to one of ordinary skill in the art. Hence, it would have been obvious to one having ordinary skill in the art, at the time of invention, to perform routine experiment to obtain optimal volume percentage ratio and etch rate as an expected result.

Respect to claim 123, Bartlett does not explicitly disclose the pH of the aqueous solution. However, Bartlett discloses the solution is an acid buffer solution. Since solution is acidic buffer, the pH of the solution must be less than 7 and greater than 2 (read on pH is about 2 to about 5). The limitation of claim 125-126 has been discussed in previous paragraphs.

5. Claims 114-115, 120-122, 124, 133 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bartlett in view of Yamazaki, and further in view of Bell et al. (US 6,309,926).

Respect to claims 115, 120, 124 and 133 Bartlett and Yamazaki fail to disclose the specific selectivity between the photoresist and dielectric layer. However, Bartlett clearly discloses that the etching between the photoresist layer (2) (i.e. organic layer) and dielectric has a very high selectivity (greater than 1) with respect to the dielectric layer (See Fig 4-5). Bartlett further shows that the photoresist layer is NOT significantly etch during the wet etching process (Fig 4-5) as well as the concentration of the chemical primarily affect the etch rate of the dielectric layer (col. 4 lines 1-5). The examiner interprets that Bartlett implicitly discloses that a person of ordinary skill can

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modify the concentration of the etching solution to increase the etch rate of the dielectric layer without significantly increasing the etch rate of photoresist layer (i.e. organic layer). Since the etch rate of the dielectric layer is increased without increasing the etch rate of the photoresist layer, the selectivity between the dielectric layer and photoresist layer is a result effective variable and its value is depended on the concentration of the etching solution. Further, in a wet etching process, Bell teaches that dielectric: photoresist selectivity is greater than 40:1 and one skill in the art can readily tailor a suitable chemistry including concentration to correspond the selectivity (col. 10 lines 11-23). The examiner interprets that Bell teaches that the selectivity is a result effective variable and a person of ordinary skills can adjust the specific value of the selectivity by varying the concentration.

It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Bartlett/Yamazaki in view of Bell by having a appropriate selectivity between the dielectric and photoresist layer because high selectivity between dielectric and photoresist layer will require a thinner in thickness of the photoresist layer. Further since the selectivity is the result effective variable (as suggested by Bartlett and Bell), it would have been obvious to one having ordinary skill in the art, at the time of invention, to perform routine experiment to obtain optimal selectivity as a expected result.

Respect to claim 114, the cited prior art does not explicitly disclose the organic material etch rate. However, the cited prior art clearly teaches the etch rate of the dielectric layer (Yamazaki) and the selectivity between the dielectric layer and photoresist layer (i.e. organic layer). The etch rate of the organic layer can be

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calculated base on the etch rate of the dielectric layer and the selectivity. Further both Bartlett and Bell teaches that the etch rate is result effective variable and can be adjust base on the concentration. The result effective variable is commonly determined by routine experiment. The process of conducting routine optimization experiments so as to produce an expected result is obvious to one of ordinary skill in the art.

The limitation of claims 121-122 has been discussed in previous paragraphs.

6. Claim 79 is rejected under 35 U.S.C. 103(a) as being unpatentable over Anzaki et al. (US 6,277,507) in view of Kwag et al. (US 6,232,228).

Anzaki discloses a method comprising the steps of:

applying an aqueous solution to remove low-k dielectric material (i.e., SiO₂) from the surface of the substrate, the aqueous solution effective to selectively remove the low-k dielectric at a rat of 255 nm/min (255 nm/min = 2550 Angstrom/min; read on "greater than about 2000 angstroms per minute");

the aqueous solution comprises hydrogen fluoride (HF) and nitric acid in a ratio of 3:2 (3:2 = 1.5:1; col. 9 lines 45-61).

Anzaki does not explicitly disclose the pH of the solution. However, the solution is a strong acidic, therefore the pH of the solution should be around 2-5. Claim 79 differs from Anzaki by the specific ratio of HF to nitric acid (i.e., 2:1 ratio). In an etching method, Kwag discloses a solution comprise HF and HNO₃. Kwag further disclose the weight percent ratio between HF and HNO₃ is a result effective variable (Fig 8, col. 7 lines 37-49). It is known in the art, that one can convert weight percent ratio to volume ratio if the density of the solution is known. The examiner will interpret that Kwag

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implicitly discloses that the volume ratio is a result effective variable. The result effective variable is commonly determined by routine experiment. The process of conducting routine experiments so as to produce an expected result is obvious to one of ordinary skill in the art. Hence, it would have been obvious to one having ordinary skill in the art, at the time of invention, to perform routine experiment to obtain optimal volume ratio as an expected result.

Response to Arguments

7. Applicant's arguments with respect to claim 79 have been considered but are moot in view of the new ground(s) of rejection.

Applicant's arguments filed 2-24-2003 with respect to all the pending claims except claim 79 have been fully considered but they are not persuasive.

The applicants argues that "Bartlett particularly teaches the use of wet etching of NH_4F and citric acid – in order to overcome the problems of ... prior art etchants of NH_4F and HF or acetic acid". The examiner recognizes that Bartlett disclose the use of NH_4F . However, Bartlett clearly discloses the use of HF in combination with organic complexing agents such as organic acid (col. 2 lines 53-65, col. 3 lines 35-55).

The applicants further argues that "A person skill in the art reading Bartlett's disclosure and particular use of a NH_4F :citric acid ... would not be motivated to substitute with another etchant formulation". The examiner disagrees. The examiner recognizes that Bartlett discloses the use of NH_4F :citric acid solution. However, the examiner still maintains that Bartlett discloses the same chemical components (i.e., HF and organic acid) with the instant invention. Since Bartlett discloses the same chemical

components with the instant invention, there is no need to substitute Bartlett's etchant formulation with another formulation. The examiner use Yamazaki reference to discuss that the dielectric etch rate is a result effective variable, and it would be obvious to perform routine experiments to obtain optimal etch rate.

The applicants further argue that "Bartlett teaches a particular etch solution of NH_4F :citric acid and teaches away from etch solution of NH_4F :acetic acid or NH_4HF ". The examiner disagrees with this argument. Teaching a way or another way is not a teaching away. Teaching another way refers to the fact that the reference teaches a preferred, or an alternative way to a claimed way of accomplishing something.

The applicants further argue that Bell does not disclose a wet chemistry formulation. The examiner agrees with the applicants that Bell does not disclose a wet chemistry. However, the examiner only use Bell's reference to prove that there is a motivation (i.e., thin resist layer) for achieving high selectivity between dielectric and photoresist layer. As discuss in above paragraphs, the examiner interprets that Bartlett already implicitly taught that the selectivity between the dielectric and photoresist is a result effective variable.

Conclusion

8. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not


mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Binh X Tran whose telephone number is (703) 308-1867. The examiner can normally be reached on Monday-Thursday and every other Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on (703) 308-3836. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9310 for regular communications and (703) 872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.

Binh X. Tran
May 27, 2003


BENJAMIN L. UTECH
SUPERVISORY PATENT EXAMINER
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